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# Simulation and experiment of a remotely operated underwater vehicle with cavitation jet technology

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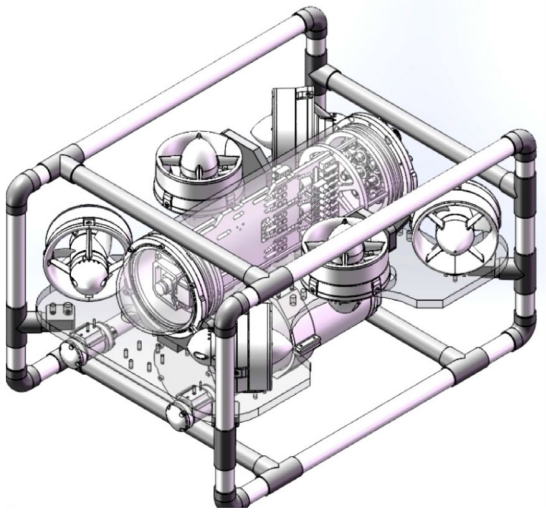
**Key words:** Underwater jet; The ROV; Cavitation jet cleaning; The nozzle structure



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# 01 Numerical simulation of water nozzle

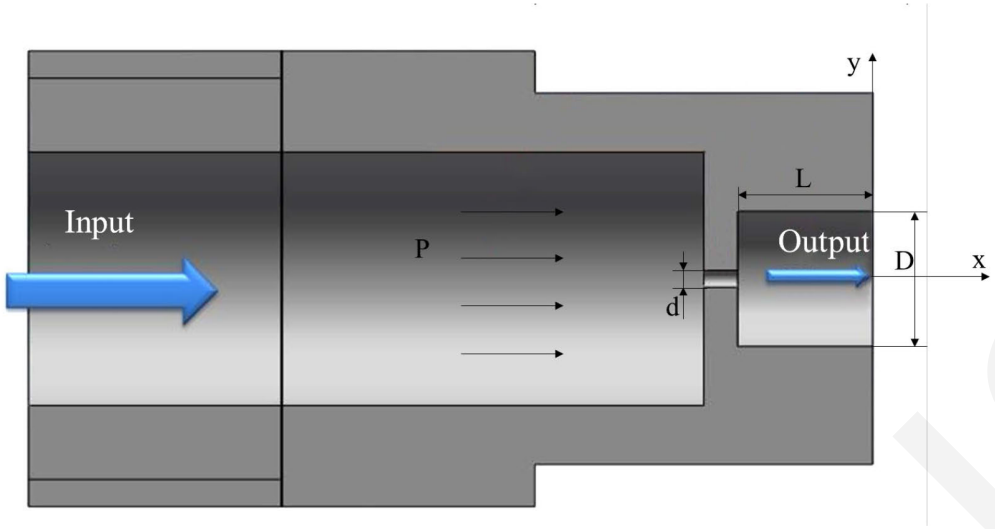


**Fig. 1 Nozzle structure with geometric parameters *P, d, L,* and *D***

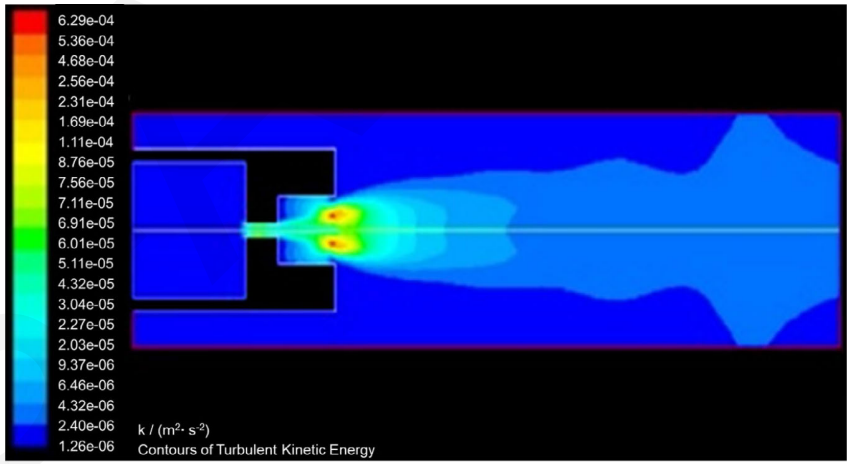


**Fig. 2 Contours of turbulent kinetic energy (TKE) of the nozzle under different parameters: *D*=16 mm, *L*= 16 mm, *P*=30 MPa**

- Given the formation conditions and requirements of the cavitation jet, the structure of the nozzle is shown in Fig. 1. Different blocked things have different surface adhesion, and the proper control parameters P-d-L-D are selected to quickly and efficiently clean things that are covered at the bottom of the hole.
- Based on the analysis of the above exit shape, When the inlet pressure P=30 MPa, throttle diameter d=2 mm, outlet length L=16 mm, and outlet diameter D=16 mm, the underwater nozzle has the highest cleaning efficiency and can meet the cleaning requirements.

# 02 Soil case simulation for ROV jet simulation analysis

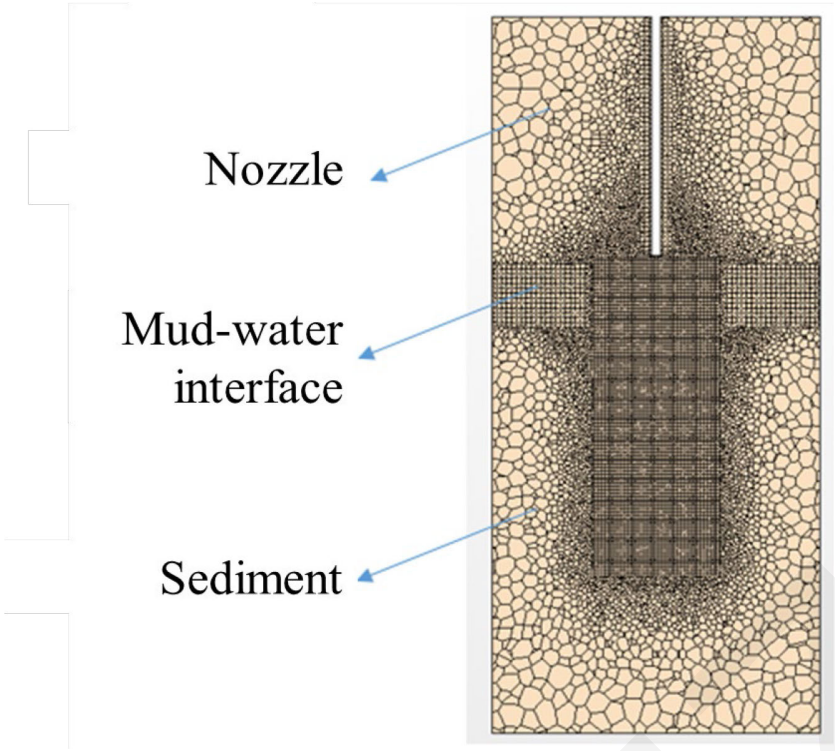


**Fig.3 Meshes of the ROV jet simulation**

Fig. 3 shows a local mesh refinement of the ROV jet water and mud interface is carried out in order to obtain more accurate results.

The scour depth decreases with the increase of jet target distance. the scour depth increases with the increase of jet flow. When the injection flow reaches a certain value, the soil scour depth increases slowly.

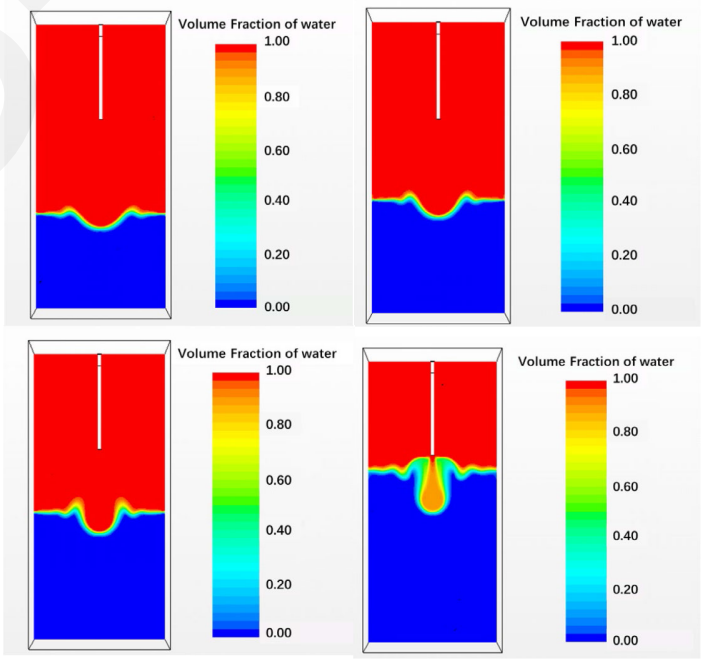


**Fig.4 Simulation results of volume fraction of water at different shooting distances**

# 03 Cavitation jet experiment

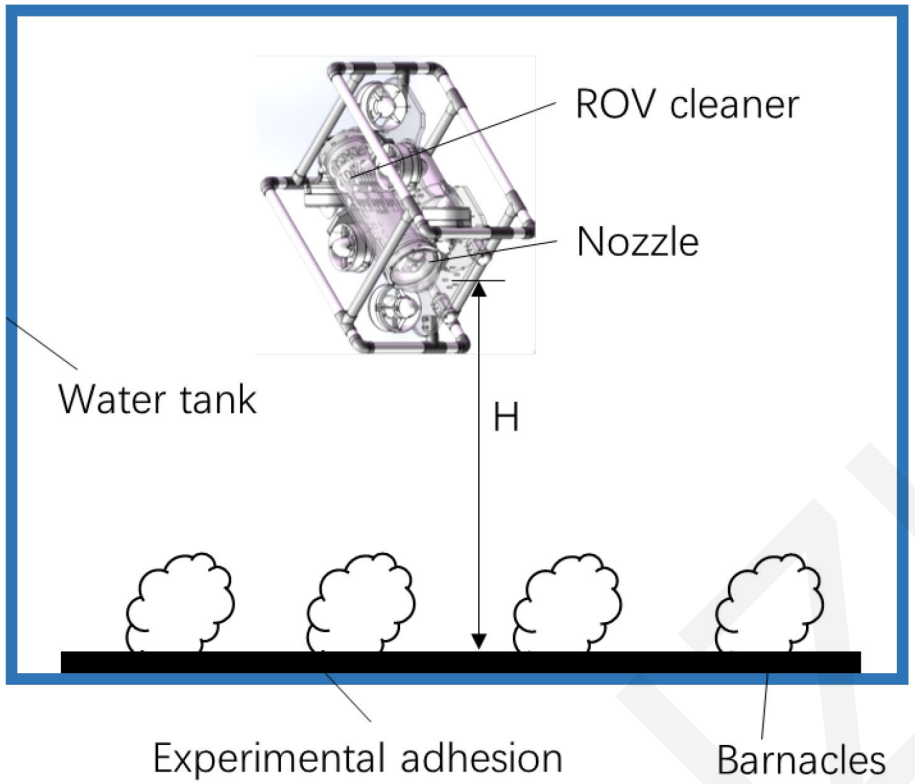


**Fig.5 Overall layout of the experimental setup (*H* is the distance between ROV and barnacles)**

- In order to verify the cleaning effect of the ROV cavitation cleaning device on the marine organisms in the laboratory, we applied four clusters of barnacles to the attachment surface with the same angle of super glue, as shown in Fig. 5, to simulate the marine life attached to the pipeline of the offshore oil platform.
- The four clusters of barnacles are cavitation cleaned by controlling the distance H of the ROV from the bottom of the water tank by 10 mm, 30 mm, 60 mm, and 100 mm, respectively, and the flushing time is 60 s.

# Conclusions

- It can be clearly seen that the jet depth decreases as the thrust target distance increases. However, when the pressure is constant and the distance is too close, the erosion intensity will be weakened by the excessive resistance when hitting the sea creatures.
- The designed cavitation nozzle is capable of crushing most of the jacket sea creature samples, indicating that it has the ability to clean out most of the jacket sea creatures.
- The actual cleaning effect of the cavitation cleaning device is similar to the expected one. The lower sea creatures are crushed to disengage the upper sea creatures.

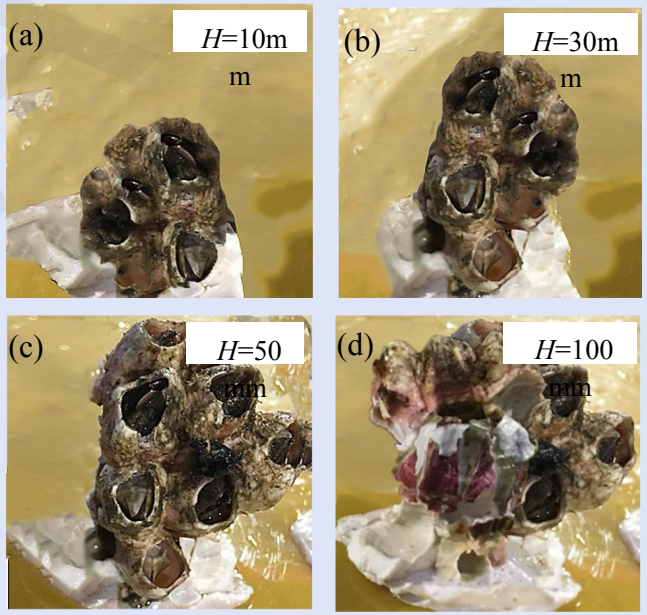


**Fig.6 Residue of the attached plate after cavitation cleaning in the case of *H*=10 mm (a), *H*=30 mm (b), *H*=60 mm (c), and *H*=100 mm (d)**

## Acknowledgements

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